HYDROGRAPHY WITH AFFORDABLE AUV SYSTEMS

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LONG-TERM GOALS

To demonstrate the capability of current generation AUVs (autonomous underwater vehicles) to perform as useful hydrographic tools capable of acquiring data and generate descriptions of the local scene and identify areas of interest and uncertainty.

OBJECTIVES

- Integrate a high resolution sidescan sonar into an existing AUV (REMUS) and provide the necessary infrastructure to allow it to be an effective hydrographic tool.
- Participate in the 1997 Naval Oceanographic Office AUV Fest, and provide data in real time to allow the system to be effectively evaluated.
- To post process the data and generate a final report so that meaningful evaluation can be completed.
- To optimize time in the water, as experience has shown that this is the best way to improve vehicle and system performance.

APPROACH

The basic approach is to use a low cost, off the shelf side scan sonar. Two potential candidates identified themselves early on: both Imagenex and Marine Sonics Technology (MST) had suitable systems. The MST system was selected based on conversations with the Science Officer for NAVSPECWARCOM, who had had satisfactory experiences with that system.

The MST system uses a Windows 3.1 interface. For this reason, a second 486 PC-104 CPU was added to REMUS to handle the side scan interface. Data storage was accomplished using a 1.4 gigabyte laptop sized hard drive. Since the sidescan only uses 1 Megabyte every three minutes, this hard drive is sufficient to store about 70 hours worth of data. MST was contracted to deliver a system with minor modifications: rather than providing a towfish, the transducers and pre-amps were provided separately.

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The core REMUS hardware was modified in the following ways:

- A power switch, under control of the REMUS program was added. This allowed the REMUS software to reset the sidescan CPU in the event it detected a malfunction.

- A serial port was added to allow the REMUS system to provide navigation and control data to the sidescan and receive status information from the sidescan.

- The housing was lengthened by about 4 inches to provide additional floatation for the sidescan hardware. This also allowed feed throughs for the sidescan transducers to be added.

The transducers were mounted using hose clamps. While this simple mounting added to the vehicle drag, it made it easy to adjust the angle of the transducers. This allowed experimentation to find the optimum mounting angle. Foam was added above and below the transducers for additional floatation.

Permanent storage of sidescan images was accomplished using a CD-ROM writer that plugged into an existing parallel port on the sidescan CPU.

WORK COMPLETED

1 The MST sidescan sonar was purchased and integrated to an existing REMUS vehicle, already equipped with an RDI Acoustic Doppler Current Profiler (ADCP), a CTD, and an OBS.

2 Five broad band coded transponders were fabricated for use in navigating the vehicle.

3 Software was developed to allow REMUS to power up the sidescan and reset it by power cycling if it failed for any reason. Software was also developed to provide the user with a map of sidescan images, so that if a particular area was of interest, the user could easily locate the correct file.

1 Software was developed to provide the vehicle's navigation data to the sidescan so that sidescan images could be properly correlated with latitude and longitude positions on playback.

2 The system was field tested aboard the R/V Gyre, and all data was provided to the Naval Oceanographic Office in CD-ROM format at the completion of the test, before we left the ship.

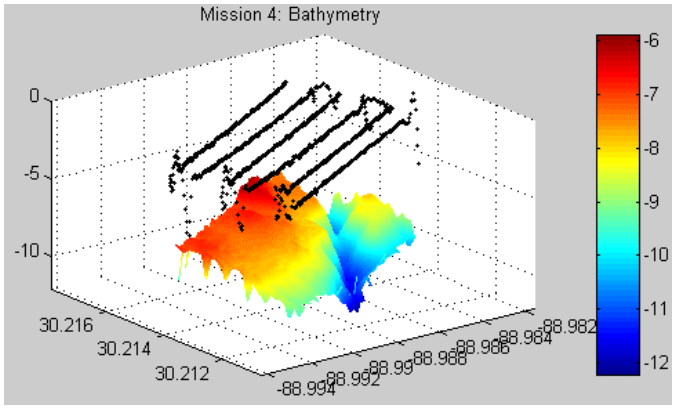

Fig 1 Bathymetry Data from Ship Island reveals an inshore channel 5 meters deeper than the surrounding area

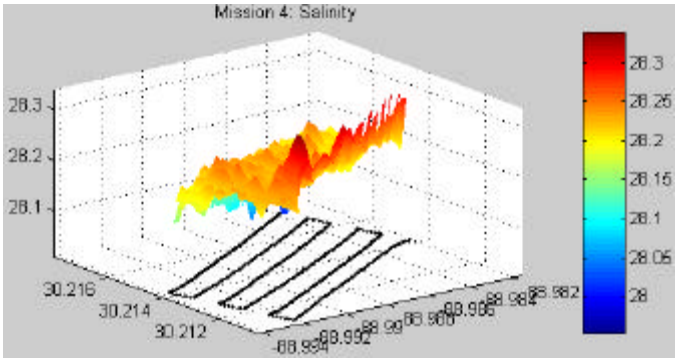

Fig 2 Salinity Data from ship island. Inshore area is more saline than the offshore area

RESULTS

1 REMUS successfully generated highly detailed sidescan images. This detail is evidenced not only by the high resolution images of the Liberty ships, but by the vehicle's ability to repeatedly image the mine like objects deployed in the survey area.

2 REMUS performed 10 missions, with an accumulated mission time of nearly 6 hours

3 REMUS successfully generated bathymetry data. At test area A (near the north west corner of ship island), this data indicated the presence of a channel 5 meters deeper than either the inshore or offshore area.

4 REMUS successfully demonstrated it could repeatedly survey a ½ kilometer by ½ kilometer area with 80 meter sidescan spacings (50% overlap) in about 40 minutes.

Fig 3 Sidescan image of Liberty ships

5 REMUS successfully demonstrated that it was an easy to use vehicle, which most computer literate observers would quickly feel comfortable setting up and operating.

6 REMUS successfully demonstrated that it could provide useful bathymetric, sidescan, and oceanographic data within minutes of recovery, and in a format that would allow it to be easily integrated into a predictive coastal sampling network for nowcasting and forecasting.

IMPACT/APPLICATIONS

The immediate impact of this program is that a large number of Oceanographers were educated as to the capabilities of AUVs. It is now apparent that many tasks which required large vessels to perform an expensive survey of several days can now be accomplished quicker and at lower cost by a fleet of inexpensive AUVs.

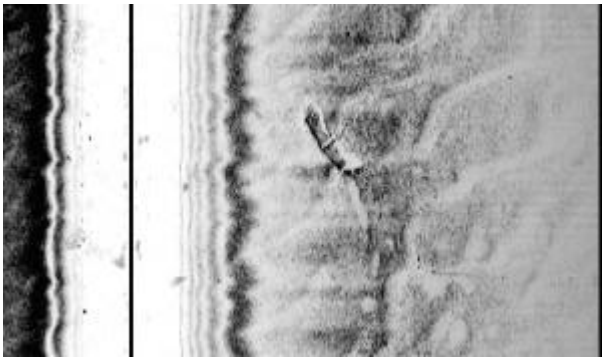

Fig 4 Sidescan image of mine-like object

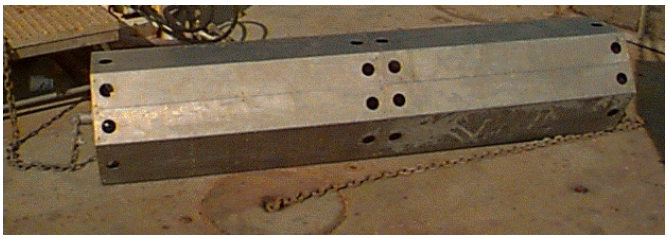

Fig 5 Mine-like object

In addition, this program provided a valuable opportunity for AUV systems developers to compare hardware and software methodologies. The cross pollination will yield valuable benefits in all future AUV programs. The images and data provide a valuable benchmark for future AUV programs.

TRANSITIONS

Current transition points for REMUS include the Navy Special Warfare program and the National Ocean Partnership Program.

The Navy Special Warfare group (Seals) are extremely interested in the mine hunting capabilities of REMUS, and a program has been initiated to use REMUS for very shallow water mine counter measures. This hydrographic program allowed a preliminary look at the vehicle's capability in this area.

The National Ocean Partnership Program will use REMUS in an oceanographic and hydrographic field test at LEO-15, a national littoral laboratory off the coast of New Jersey. In this field program, REMUS will be used to provide current, temperature, salinity, sidescan, and optical backscatter data to a near term model designed to allow nowcasting and forecasting. This model will drive the sampling strategy.

RELATED PROJECTS

1. Predictive Coastal Modeling LEO-15; NOAA grant #NA46RU0149. This program is designed to use REMUS to provide a near term predictive coastal sampling capability of nowcasting and forecasting using oceanographic models.

2. Autonomous Network Docking Node; ONR N00014-96-5021. This program is tasked to develop an autonomous docking station for REMUS. This will allow REMUS to remain deployed in an area for weeks or even months at a time, gathering data and transmitting it in near real time for inclusion into oceanographic models.

3. Naval Special Warfare Support With REMUS; ONR N00014-98-1-0135. This program is tasked to adapt REMUS to the needs of special warfare. The immediate need is to create a system to allow NSW to determine the location of mines in littoral waters.

4. Multi Scale Model Directed Sampling with Autonomous Systems at a National Littoral Laboratory; ONR; Rutgers Subcontract Agreement 894; This program will use REMUS in a field program at the LEO-15 site to study large scale oceanographic processes. The vehicles will be programmed and launched from their docking stations which have been developed with ONR and NSF funding.

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